MEMS

- Micro-scale devices fabricated using techniques originally developed for IC fabrication:
  - Repeatable processes
  - Precise features
- System integration:
  - Components and associated electronics (signal processing, feedback control, etc.) on the same chip

Major Markets
- Automotive
- Information Technology
- Telecommunications
- Biomedical
- Environmental/Industrial
- Aerospace

MEMS Applications (1)
- Sensors
  - Gyroscope
  - Accelerometer
- Actuators
  - Comb drive
  - Motor

MEMS Applications (2)
- Optical/RF Components
  - Optical Switch
  - Inductor
- Mechanical Components
  - Hinge
  - Gears

Design Challenges
- No standard processes
- No set of primitive elements for simulation
- Scaling effects of miniaturization:
  - Thermal/mass transport properties
  - Thin-film material properties
  - Increased surface-area-to-volume ratio
  - Small inertial mass -> higher resonance (faster response)
  - Surface forces (capillary, friction, stiction, etc.)
- Integrated electronics
- Testing & packaging
- Interdisciplinary:
  - Mechanical: structural, thermal, fluids, etc.
  - Electrical
  - Optical/RF
  - Biology, chemistry, physics
Multidisciplinary Design Team

- MEMS component designers
  - Optimizing component performance
- MEMS circuit designers
  - Designing better signal-processing or feedback control circuits for MEMS devices
- MEMS system designers
  - Integrating MEMS components and electronics into their applications
- MEMS foundries
  - Optimizing the process parameters for MEMS applications and bridging the gap between designers and foundries

Component Design Tasks

- Layout editing
- 3D solid model generation
- FE meshing optimized for MEMS structures
- Detailed FE/BE analysis
- Interfaces with optical and RF solvers
- Process simulation and design

System-Level Design Tasks

- Behavioral simulation
- Optimization
- Design of electronics, MEMS devices and packaging
- Tradeoffs and “what if” analysis
- Integrated design database
- Libraries of characterized devices
- Interfaces with standard EDA, RF, optical design tools

Design Goals

- High yield
  - Statistical tools; design centering
- Low cost
  - Cost analysis tools
- Fast time-to-market
  - Re-usable libraries
- Optimization
- Best technology
  - Integrated design tools
- Collaborative and multiphysics design
  - Design -> fabrication -> packaging -> analysis -> testing

MEMSCAP CAD Tools Overview

- MEMS Xplorer
  - Unix-based component design tool
- MEMS Pro
  - PC-based complete design package

MEMS Pro V3 Overview

- Stand-alone PC-based design package
- Fully customizable
- Complete design flow
  - System-level design tools
  - Component-level design tools
  - FE and EM tools
- Component library includes standard MEMS components:
  - Layouts
  - Schematics
  - Macro (behavioral) models
- Foundry setups
MEMS Pro Design Flow

MEMSCAP CAD Presentation

- Presentations
  - System-level design tools
  - Component-level design tools
    - Layout
    - 3D modeling
    - DRC
  - MEMS Pro ANSYS Add-Ons
  - ANSYS MEMS features

- Hands-on tutorial
  - Creating schematics
  - System-level simulations
  - Optimization
  - Layout editing with 3D model generation
  - Design Rule Checking